[Detailed Description of the Invention] JP 2002-207992
[0001]
[Field of the Invention]This invention relates to an image processing method and an image processing device, and relates to a suitable image processing method and image processing device to extract an area of interest from image data with high precision especially.
[0002]
[Description of the Prior Art]As an imaging device, if it is a two-dimensional picture, there is an X ray imaging apparatus, for example, and if it is a three dimensional image, there is a CT device, an MRI device, a SPECT device, or a PET device, for example. The picture picturized by these devices is expressed by the concentration information about a certain point in a picture. For example, on a medical-application way, the existence of a lesion, etc. are diagnosed from such concentration information paying attention to an area of interest, for example, an organ. It can be called foundations of handling of a picture not only a medical-application way but to extract an area of interest from a picture. For this purpose, as shown in drawing 13, the Image Processing Division method which extracts an area of interest by the extraction part 1 based on the concentration information of the inputted image itself [this], and is outputted as the processing picture F from the inputted image A is used widely.
[0003]As a method of extracting an area of interest from a certain picture, conventionally, the threshold which distinguishes an area of interest and other fields is set up, and the threshold process which extracts an area of interest based on this threshold, the edge extraction processing which extracts objective contour shape based on the light shade distribution shape of a picture, etc. are used widely.
[0004]For example, in conventional technology given in JP,H7-271997,A, a function image is created from image data, a mask pattern is generated based on this, and the masked work is performed. He processes image data into dividing ridge shape a priori, and is trying for this dividing ridge to extract an area of interest in conventional technology given in JP,H11-272865,A.
[0005]
[Problem(s) to be Solved by the Invention]In the conventional technology given in JP,H7-271997,A mentioned above, there are problems -- an original area of interest cannot be protruded, cannot extract all areas of interest, or the continuity of a border line is not maintained by the creation state of a mask pattern. Although this can also consider that conventional technology given in JP,H11-272865,A is a kind of threshold process and the continuity of the border line of the extracted field is guaranteed, In order to depend for the contour shape extracted on the processing method which processes image data into dividing ridge shape, extracting the outline of an area of interest correctly is not guaranteed. That is, in each conventional technology mentioned above, there is a problem that shape of an area of interest cannot be extracted with sufficient accuracy. the time series data to the part where JP,H11-272865,A is the same -- there is also a problem that it is required.
[0006]The purpose of this invention is to provide the image processing method and image processing device which can extract the shape of an area of interest with sufficient accuracy from the inputted picture.
[0007]

[Means for Solving the Problem]In an image processing method which extracts an area of interest in a picture, the above-mentioned purpose is to extract an outline picture of said area of interest out of said picture, to perform fitting processing with data which defined standard shape of said area of interest, and said outline picture, and to ask for detailed images of said area of interest, and is attained.
[0008]Suitably, in the above, data which defines standard shape of an area of interest is described using characteristic quantity defined for every kind of area of interest, and said outline picture is extracted still more suitably based on a concentration value and a threshold of a picture.
[0009]A 1st extraction means by which this invention extracts an outline picture of said area of interest out of said picture in an image processing device which extracts an area of interest in a picture, A database holding data which defined standard shape of said area of interest, A fitting means to perform fitting processing with said outline picture extracted by said 1st extraction means, and formed data corresponding to said area of interest read from said database, An image processing device provided with a 2nd extraction means to ask for detailed images of said area of interest based on this fitting result and the above-mentioned outline picture is indicated.
[0010]An image processing device [fitting / this invention / with an image processing device / that the above-mentioned fitting means measures characteristic quantity extracted from said outline picture, and characteristic quantity of data of a database]. An image processing device [fitting / image processing device / that the above-mentioned fitting means makes either of data of a database, and said outline picture fit the other]. An image processing device performs linear transform processing to one of the above, performs nonlinear transformation processing to one of these which made the other fit roughly and fitted by next, and it was made to make fit the other is indicated.
[0011]
[Embodiment of the Invention]Hereafter, one embodiment of this invention is described with reference to Drawings. Although this embodiment describes the example which extracts an organ from the medical-application three dimensional image obtained by a three-dimensional imaging device like CT or MRI, it is clear that it does not matter even if the object may not be a medical image, or may not be a three dimensional image and an area of interest is not an organ.
[0012]Drawing 1 is a block lineblock diagram of the image processing device concerning a 1st embodiment of this invention. The database 4 about the shape in which an area of interest is standard in addition to the first extraction part 2 equivalent to the conventional extraction part 1 which shows drawing 13 this image processing device, Have the fitting part 3 and the second extraction part 5, the processing previous image A is inputted into the first extraction part 2, and the picture B is extracted, The data C from this picture B and the canonical form-like database 4 is inputted into the fitting part 3, the pictures A and B and the data D are outputted to the second extraction part 5 from the fitting part 3, and the after-processing picture F is outputted so that the second extraction part 5 may mention later for details.
[0013]Hereafter, Image Processing Division in this embodiment is explained using the picture A, the picture B, the data C and the data D which are shown in drawing 5 - drawing 10, respectively, the picture E, and the picture F. The picture made into a processing object with this example gestalt is three-dimensional medical imaging, and

extracts the blood flow which is an area of interest, and the picture of a blood vessel from this picture.

[0014]The inputted picture A (drawing 5) receives the extracting processing of a rough area of interest by the first extraction part 2 first. As the extraction technique, methods, such as a threshold process, edge extraction processing, and a dividing ridge method, and those combination can be considered, for example. According to this embodiment, it extracts as an example by the method by the domain extension method (drawing 2) which is the combination of a threshold process and edge extraction processing.

[0015]Drawing 2 is a flow chart which shows the extracting procedure which used the domain extension method in the first extraction part 2. The picture A of drawing 5 is expressed with the concentration value in each pixel of a picture. This picture A is a blood vessel picture, and is an example in which other soft tissue A_2 which lap with this blood vessel in part, and A_3 exist, and also diseased tissue A_1 exists. A domain extension method performs domain extension, incorporating the connected area considered to belong to the same field one by one, and extracts the required whole field from starting point P_1 set up in the area of interest. Then, starting point P_1 is first set up in an area of interest (Step S1), Impaction efficiency is performed one after another from this starting point P_1, it is considered as determination object point P_i for every position (Step S2), and that decision point P_i judges whether it is the same field as the field where starting point P_1 belongs (Step S3).

[0016]this embodiment -- as the criteria in Step S3 -- (1) -- in the same field, the concentration of each pixel f (P_i) should be in a certain density range alpha.

| A thing with small (below the threshold beta) density difference of f(P_i) |<alpha and (2) adjacent points.

| f(P_i)-f(P_j) |<beta (however, Pj adjacent point of Pi)

It judges [whether two conditions to say are fulfilled and].

[0017]The decision point which fulfills both conditions is carried out in an area of interest (step S4), and the decision point which does not fulfill both conditions is carried out the outside of an area of interest (Step S5). And when the existence of the next decision point is judged at Step S6, a decision point exists, it returns to Step S1 and the decision processing of the inside and outside of an area of interest of all the decision points is completed, the area-of-interest extracting processing by this domain extension method is ended. Although the outline picture it was considered that was the same field may protrude a actual area of interest or may be insufficient in this domain extension method, rough field extraction is possible. The outline picture extracted by this first extraction part 2 is the picture B of drawing 6. In the picture B, soft tissue A_2 and A_3 are removed, and flash field B_1 which does not exist in the picture A, and insufficient field B_2 are the examples added conversely. Diseased tissue A_1 remains as field B_1 as it is.

[0018]In addition to the extraction outline picture B, the fitting part 3 receives the canonical form-like data (it is henceforth called the data C (drawing 7).) about an area of interest from the canonical form-like database 4.

[0019]When making the organ of a human body into an area of interest temporarily, it is assumed that this area of interest differs in shape or a size, for example according to a race, sex, age, etc. In other pictures and areas of interest, it is considered easily the same way that shape and a size have dispersion. Therefore, fitting between the picture B extracted as shape of the outline of an area of interest, and the data C which is canonical

forms-like.
[0020]For example like the picture A and the picture B, the data C which defines the shape of a canonical form may be data of composition so that it may have a concentration value in each pixel, and here, Or it may be the engineering CAD data or data like a mathematical theory which defines the shape of a subject, and they may be the both further.
[0021]This embodiment describes the case where it is given as an example by formed data or a mathematical theory for which the data C is used by engineering CAD. By this method, the standard shape of an area of interest is described using the set of required characteristic quantity as the data C.
[0022]Drawing 3 (i) and (ii) are the explanatory views about the characteristic quantity of a blood vessel and a blood flow. Simply, since the blood vessel as shown in drawing 3 (ii) is carrying out tubed shape, in order to describe a blood vessel, distribution etc. of the thickness of the blood vessel wall in alignment with the solid angle from distribution, a strain, and the center line and center line of a radius of the blood flow which met a center line and this center line, for example should just be defined. It is also considered that the center line of a blood vessel is expressed with a certain function form in which the curve to draw contains an unknown with the elasticity of a blood vessel wall, etc. These unknowns, radius distribution, thickness distributions, etc. are characteristic quantity. The function f of the radius r (x, y) and the function g of thickness d (x, y) express the characteristic quantity Z in drawing 3 (i).
[0023]In the fitting part 3, fitting is performed by extracting and comparing the parameter (characteristic quantity) which describes formed data, i.e., shape. How to fit the data C in the picture B on the occasion of fitting, Two kinds of the method of fitting the picture B in the data C can be considered, and although whichever may be sufficient, it is necessary to memorize the procedure of returning the picture B to the original shape since the area of interest which should be extracted will be transformed when it fits the data C.
[0024]Drawing 3 explains signs that the picture B was fitted in the data C. The canonical form-like data C received from the canonical form-like database 4 is a set of the characteristic quantity which describes the standard shape of the target area of interest. The fitting part 3 fits by extracting the set of the same characteristic quantity as the data C from the extracted image B. For example, the curve which a center line draws can cut each part of a blood vessel into round slices, and can obtain it by connecting the central point obtained from there, and said unknown can be determined by fitting the function defined by the data C. It can obtain from the section of a round slice similarly about the radius of a blood vessel, and thickness. By extracting the set of such characteristic quantity from the picture B can describe the blood vessel within the picture B, and the shape of a blood flow (this is henceforth called the data D). An example of the data D is shown in drawing 8, and it is set to characteristic quantity Z={f (x, y) and g (x, y). f (x, y) is a function of the radius r, and g (x, y) is a function of thickness here.
[0025]The second extraction part 5 shown in drawing 1 receives the inputted image A (drawing 5) and the extraction outline picture B (drawing 6), and the data D (drawing 8) from the fitting part 3. Although the shape of the area of interest of the inputted image A has already been obtained as the data D by the fitting part 3, since the data D is defined as strictly standard shape, the lesion of organs, such as a tumor, is not extracted, for example. Then, final extracting processing is performed by comparing the picture B with

the data D by the extraction part 5.

[0026]The comparison with the picture B and the data D can consider taking difference, for example. the picture acquired by (difference is henceforth called the picture E by taking the difference between two pictures.), as shown in drawing 9, Partial (it is henceforth written as heights) B_2 protruded in the first extraction part 2 and insufficient partial (it is henceforth written as crevice) B_3 are extracted as E_2 and E_3, and also lesion part B_1 is extracted as E_1, and these partial E_1, E_2, and E_3 are emphasized. The judgment of whether E_1 which is this heights and crevice, E_2, and E_3 carry out lesions, such as that it is a problem of the accuracy of the first extraction part 2 or a tumor, extraction 2 is performed based on diagnostic imaging software or human judgment.

[0027]For example, if based on human judgment, since the position of heights or a crevice is identified by the picture E, the radiologist should just judge whether the part is a lesion or that is not right by the picture A. It removes about part E_2 which is not so, and E_3, adds to the data D about part E_1 judged to be a lesion, and is considered as the outputted image F (drawing 10) with data as it is about the other part.

[0028]On the other hand, not only the above methods but diagnostic imaging can also be performed by software using the data D which is a set of characteristic quantity. as opposed to the picture which is small rapidly by place G_1 which has a radius of the blood vessel in alignment with a medial axis as shown for example, in drawing 4 (ii) -- drawing 4 (i) -- since characteristic quantity (radius r) is dented greatly, it obtains a diagnostic result distinguishes this automatically and it is considered that is strangulation of a lesion, for example, a blood vessel, i so that it may be shown. Or if it is a blood vessel when the data D has a remarkably different tendency as compared with the data C, an automated diagnosis, like it is too thick and too thick can also be carried out, for example. Of course, there may also be an example which displays the above-mentioned waveform and human being diagnoses.

[0029]As mentioned above, according to this 1st embodiment, since the area of interest in an inputted image can be extracted with sufficient accuracy, diagnostic imaging can be performed using an extracted image.

[0030]Drawing 11 is a lineblock diagram of the image processing device concerning a 2nd embodiment of this invention. Although the composition of this embodiment is the same as a 1st embodiment fundamentally shown in drawing 1, it serves as data in which the data stored in the canonical form-like database 8 has a concentration value over each of the same pixel as the picture B unlike a 1st embodiment. For this reason, the processing method in the fitting part 9 of this embodiment differs from a 1st embodiment. Hereafter, only processing of the fitting part in this embodiment is explained.

[0031]Linearity or a nonlinear method, and the method that combined them as an example in this embodiment although the combination was known are explained to fitting of data with a concentration value, for example.

[0032]How to fit the data C in the picture B like a 1st embodiment on the occasion of fitting, Two kinds of the method of fitting the picture B in the data C can be considered, and although whichever may be sufficient, it is necessary to memorize the procedure of returning the picture B to the original shape since the area of interest which should be extracted will be transformed when it fits the data C. This embodiment explains how to fit the picture B in the data C.

[0033]Drawing 12 is a figure explaining the fitting method of of the data C and the

picture B which define the standard target shape. As opposed to the data which obtained the data performs linear transform to the data C and the picture B is made fitting [data / this embodiment / first] roughly (Step S20), next was obtained at this step S20, It carries out by what the data G performs nonlinear transformation and the picture B is made fitting [data] in detail is obtained for (Step S21).

[0034]Here, linear transform is a process which changes the data C with a total of nine parameters of three advancing side by side, three rotations, and three elasticity as shown in drawing 14, and is made to fit the picture B roughly.

[0035]With nonlinear transformation, two image data for fitting is divided into a small region, respectively, The node of the data C is moved according to the picture B, measuring the similarity of each node defined by division between two pictures, It is the method of making it transform the whole data C into the shape near the picture B (Reference documents: MEDICAL IMAGING TECHNOLOGY Vol.16 No.3 MAY 1998 pp.175-183).

[0036]An example of nonlinear transformation is explained using drawing 15. The data C which fitted the picture B roughly by linear transform is divided into the small region of the shape of a lattice as shown in drawing 15 (i). If the node 10 is temporarily moved to the node 11 as shown in drawing 15 (ii), the field 12, for example, the field of the slash part in a figure, containing this node will change, as shown in the field 13. The point inside the field 13 corresponding to each point inside the field 12 can be searched for by linear interpolation here. The similarity of the pixel value in that field can be found by comparing the image comparison B with the field 13 after this modification. Here, similarity with the picture B in the field 13 is set to L (13). If each node is moved like the node 11, it can ask for the similarity L (n) about all the fields that change as a result. Movement of a node is repeatedly performed so that total sigma[of said similarity L (n)] L (n) may be made into the maximum. At this time, the moving range of a node is restricted in order to hold the connectivity of each field. For example, in drawing 15 (ii), it is restricted to the range shown by the position dotted line 14 of the node 11.

[0037]According to the above techniques, the data C and detailed fitting with the picture B are possible. In this technique, if the points of comparison do not exist on the picture B near a certain node on the data C, that node does not move, but the shape of a canonical form which the data C originally has passes through it, and it is saved. Therefore, fitting which is not influenced by the portion or the insufficient portion which were protruded among the areas of interest roughly extracted in the first extraction part 2, or the lesion is possible.The data C which changed in the fitting part 9 is henceforth called the data G. The second extraction part 5 receives the picture A and the picture B, and the data G, and obtains the outputted image H by the same processing as the first working example.

[0038]As mentioned above, according to this embodiment, it becomes possible to be able to extract the area of interest in an inputted image with sufficient accuracy, and to perform high-precision diagnostic imaging using an extracted image.

[0039]The image processing method of this invention extracts a customer's area of interest based on the data requested by the customer, is possible also for applying to a service enterprise which models and delivers this extracted picture using a solid shaping apparatus, and is not limited to medical diagnoses.

[0040]

[Effect of the Invention]According to this invention, it becomes possible by using the

standard shape of the target area of interest to extract the shape of an area of interest with sufficient accuracy from the inputted picture.

[Translation done.]